2013 Title 24 Part 6 Essentials
Residential Standards

Plans Examiners & Building Inspectors

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Energy Code Ace™
HELPING YOU PLAY YOUR CARDS RIGHT

This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.

Course Goal & Objectives

Help you enforce the 2013 Title 24 Building Energy Efficiency Standards

- Identify major differences between the 2008 and 2013 California Residential Building Energy Efficiency Standards
- Identify requirements for residential new construction, additions, and alterations
- Identify the primary compliance forms and related documents
- Use the Residential Checklists for Plans Examiners or for Building Inspectors to identify errors or omissions in compliance documentation, plans and specification, and actual installations

What's New

- Welcome and Pre-test
- Introduction
- **What's New**
  - Overview of New Requirements
  - Measure-specific Overview
  - Introduction to Checklists
- Energy Standards Key Concepts
- Introduction to Plan Review and Field Inspection
- Residential Envelope Standards
- Residential Mechanical Standards
- Residential Lighting Standards
- Putting it Together
- Course Conclusion and Post-test

What's New?

We will address these topics and more throughout the day

- Increased stringency (insulation, windows, etc.)
- CEC Compliance Manager and Report Generator
- All New Forms and Form Numbers and Names
- 2015/2016 Federal Equipment Standards
- Mandatory HERS Verifications
- Photovoltaic (PV) System Credit
- Solar Ready Requirements
- Ventilation Cooling
- Existing Plus Additions Plus Alterations

CEC Compliance Manager

- All software must use the same simulation engine

  (The same compliance run on different platforms will yield identical results)

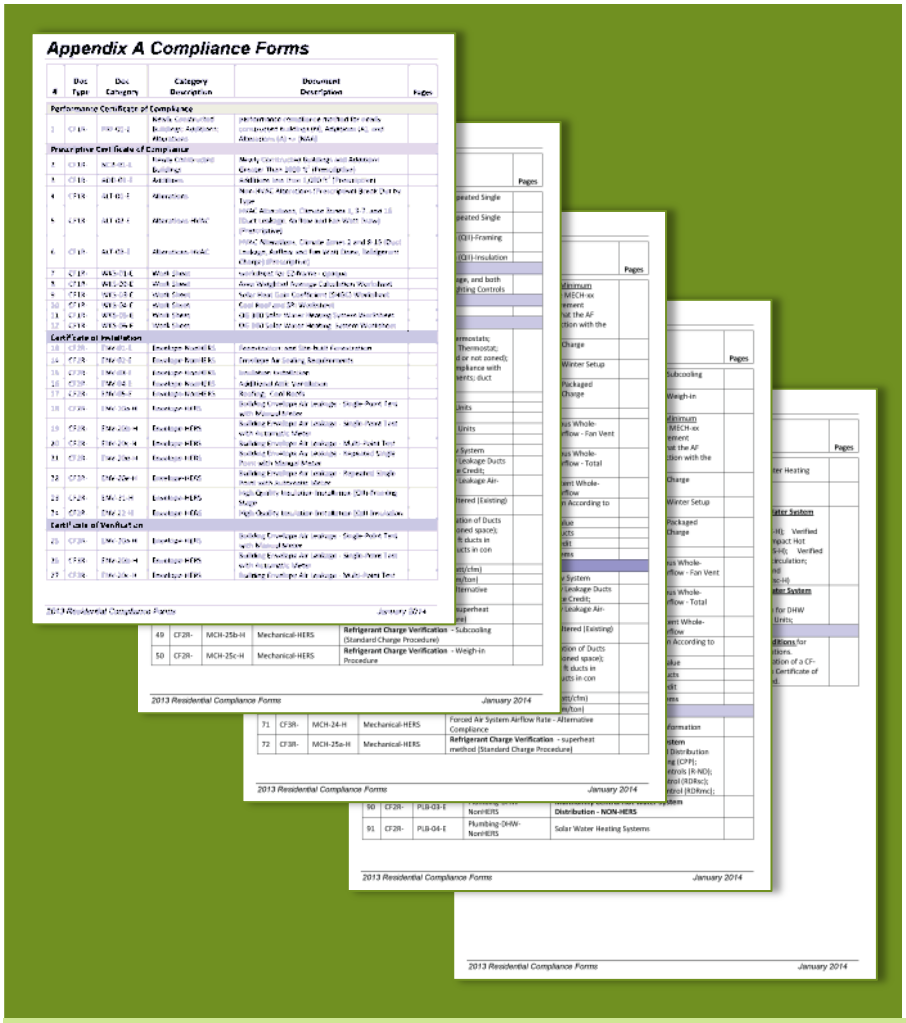
- Generating Compliance Reports requires an Internet connection

  (All reports must be generated via CEC web site, regardless of "front end")

2013 Compliance Software Approved by CEC → energy.ca.gov/title24/2013standards/2013_computer_prog_list.html

Links to CBECC-Res, Quick Start, and more → http://www.bwilcox.com/BEES/BEES.html

Residential Forms & Form Names



- Re-designed
- New names
- More of them (e.g., different forms for different aspects of a project or for different types of projects)

Additional information on the new forms is in Module 3. Energy Standards Key Concepts

Federal HVAC and DHW Standards

Water heaters manufactured April 16, 2015 or later

- Higher minimum Energy Factor

Air conditioners manufactured January 1, 2015 or later

- "California minimums" (see note below slide)
- Higher minimum efficiency
- SEER and EER

Central gas furnaces

- No change from May 1, 2013 minimums

Additional information in "Package A Quick Reference" (next module) and in Module 6: Residential Mechanical Standards

Mandatory HERS Verifications

- New residential construction must have HERS verification of:
  - Duct Sealing*
  - Airflow and Fan Watt Draw*
  - Indoor Air Quality Fan
- All residential new construction will have at least one HERS measure
- As with the 2008 Standards, projects with HERS measures must have the CF1R registered with a HERS provider

* Exceptions apply.

The HERS Registration process is addressed in Module 3. Energy Standards Key Concepts

Specific HERS measures are addressed in Modules 5: Residential Envelope Standards and 6: Residential Mechanical Standards

PV System Credit

- The PV System Credit is available only if:
  - The Performance Approach is used
  - The project is in Climate Zones 9-15
  - The system is ≥ 2 kWdc*
  - The energy budget is based upon the equipment meeting the 2015/2016 federal equipment efficiency standards (even if permitted in 2014)
- PV System credit does not require HERS verification unless getting rebate from the New Solar Homes Partnership (NSHP)

* kilowatts direct current

A typical 2kWdc system often has approximately eight PV panels

Solar Ready

"Solar ready" is a mandatory requirement for new buildings that are:

- Low-rise multifamily

or

- Single family in subdivisions with ten or more single family residences

Solar ready requirements are addressed in Modules 5: Residential Envelope Standards and 6: Residential Mechanical Standards

Ventilation Cooling

Source: 2013 Residential Compliance Manual

Ventilation cooling

- Is new Prescriptive Requirement in Climate Zones 8–14
- May be accomplished via:
  - Whole house fan

  OR

  - Central fan system

Ventilation cooling requirements are addressed in Module 6: Residential Mechanical Standards

Existing Plus Additions Plus Alterations (E+A+A)

HERS verification BEFORE demolition and permitting…

To get full credit for the improvement of existing conditions (versus "standard design conditions") when using the performance approach:

- Existing conditions must be verified by a HERS Rater
- Verification must be done before:
  - Demolition
  - Equipment removal
  - Applying for a permit

This applies to HVAC, DHW, insulation, fenestration, etc.

More information on E+A+A and HERS verification is addressed in the next module (Module 3: Energy Standards Key Concepts)

Energy Standards Key Concepts

- Welcome and Pre-test
- Introduction
- What's New
- **Energy Standards Key Concepts**
  - Mandatory, Prescriptive, Performance — Defining the Difference
  - Prescriptive Package A
  - Additions and Alterations — Defining the Difference
  - Residential Compliance Forms
  - HERS Registration and Verification Process
- Introduction to Plan Review and Field Inspection
- Residential Envelope Standards
- Residential Mechanical Standards
- Residential Lighting Standards
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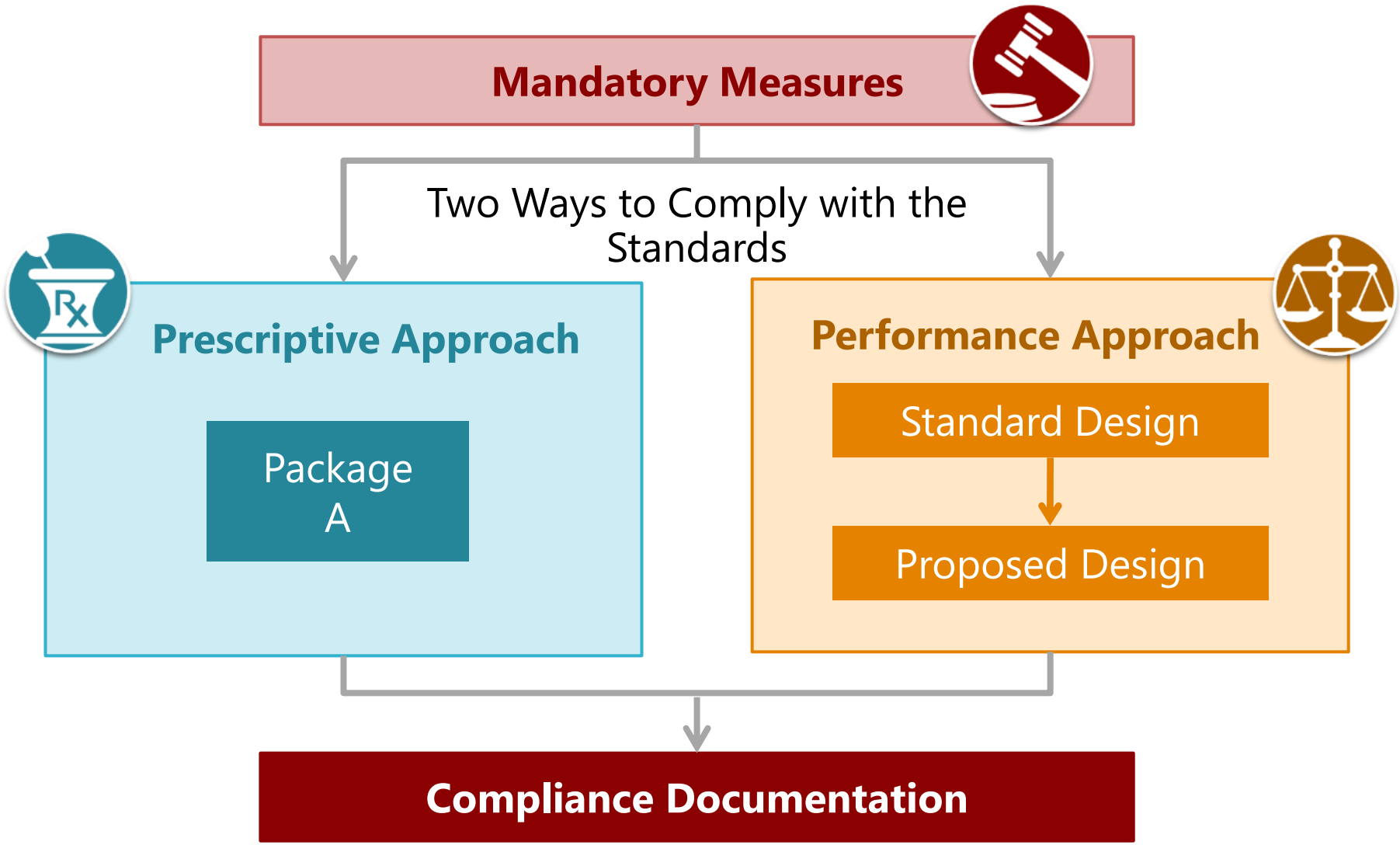
Mandatory Measures, Prescriptive Approach, Performance Approach — Defining the Difference

Mandatory, Prescriptive, Performance: Defining the Difference



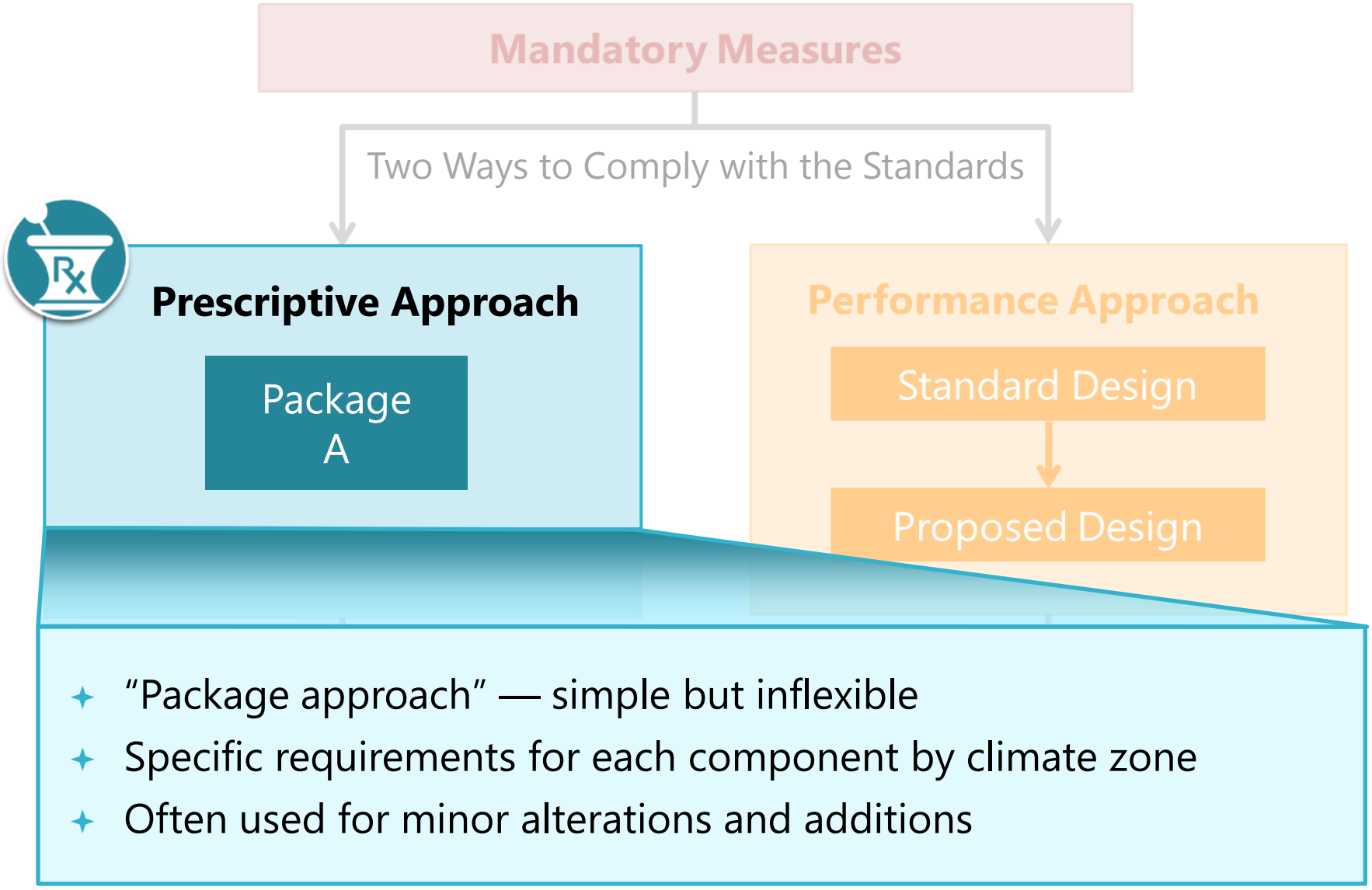
Mandatory, Prescriptive, Performance: Defining the Difference

Mandatory Measures

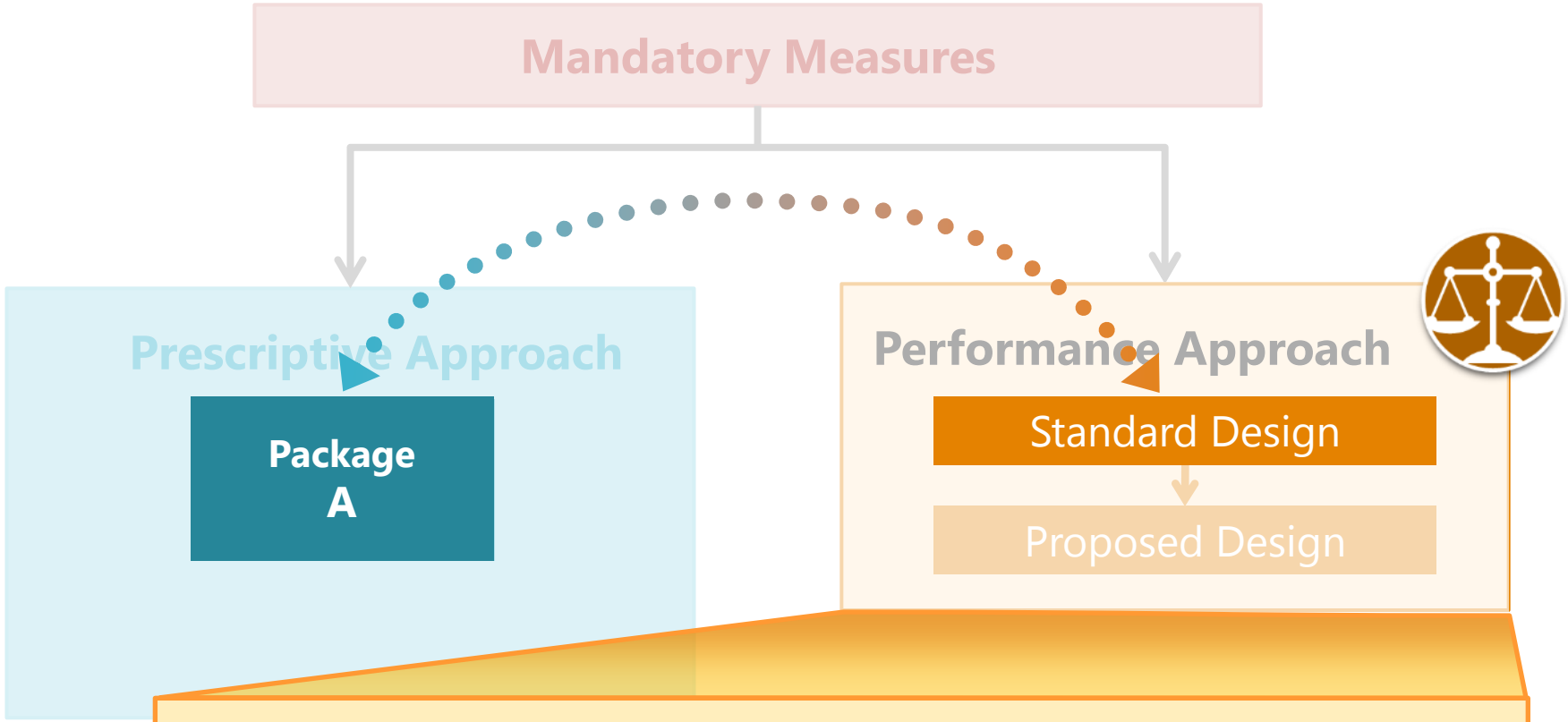
- **Must** be met, always — **may** be exceeded
- Generally focus on:
  - HVAC distribution systems
  - Whole-house ventilation systems
  - Infiltration control
  - Lighting
  - Insulation levels
  - Minimum equipment efficiency
  - Requirements for Solar Ready Buildings

Compliance Documentation

Mandatory, Prescriptive, Performance: Defining the Difference



Mandatory, Prescriptive, Performance: Defining the Difference



- Software-based approach — flexible but complicated
- Most common for new construction
- Must meet energy budget based on Prescriptive Package A

Prescriptive Package A

Prescriptive Package A Overview

When reviewing draft compliance reports, pay attention to details that are significantly different from the baseline ("standard" design based on Package A)

Package A

- "Baseline" for compliance
- Conventional construction: the reference Prescriptive Package
- Basis for Performance Approach standard design
- Table 150.1-A in the Standards

Focus on Package A – Table 150.1-A

TABLE 150.1-A COMPONENT PACKAGE-A Standard Building Design

				Climate Zone														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Building Envelope	Insulation[1]	Roofs /Ceilings		U 0.025 R 38	U 0.031 R 30	U 0.031 R 30	U 0.031 R 30	U 0.031 R 30	U 0.031 R 30	U 0.031 R 30	U 0.031 R 30	U 0.031 R 30	U 0.031 R 30	U 0.025 R 38	U 0.025 R 38	U 0.025 R 38	U 0.025 R 38	U 0.025 R 38	U 0.025 R 38
		Walls	Above Grade	2x4 Framed[2]	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5	U 0.065 R 15+4 or R 13+5
				Mass Wall Interior[3]	U 0.070 R 13	U 0.070 R 13	U 0.070 R 13	U 0.070 R 13	U 0.070 R 13	U 0.070 R 13	U 0.070 R 13	U 0.070 R 13	U 0.070 R 13						
				Mass Wall Exterior[3]	U 0.125 R 8.0	U 0.125 R 8.	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0	U 0.125 R 8.0						
			Below Grade	Per															
		Floors		R															
				Concr															
		Radiant Barrier																	
	Roofing Products	Low-sloped		Ag Re															
				T Er															
		Steep Sloped		Ag Re															
				T Er															
	Fenestration	Maximum U-fac																	
		Maximum SHC																	
		Maximum Total																	
		Maximum West F Area																	

CONTINUED: TABLE 150.1-A COMPONENT PACKAGE-A Standard Building Desig

			1	2	3	4	5	6									
HVAC SYSTEM	Space Heating[8]	Electric-Resistance Allowed	No	No	No	No	No	No									
		If gas, AFUE	MIN	MIN	MIN	MIN	MIN	MIN									
		If Heat Pump, HSPF[6]	MIN	MIN	MIN	MIN	MIN	MIN									
	Space cooling	SEER	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
		Refrigerant Charge Verification or Charge Indicator Display	NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
		Whole House Fan[7]	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	NR	NR
	Central System Air Handlers	Central Fan Integrated Ventilation System Fan Efficacy	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Ducts	Duct Insulation	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-8	R-6	R-6	R-8	R-8	R-8
Water Heating	All Buildings		System Shall meet Section 150.1(c)8														

Package A

- Table 150.1-A = "meet or beat" values for Package A
- Creates baseline reference (standard design's energy budget) for Performance Approach

Additions and Alterations: Defining the Difference

What do you think…

SHOW ALL

Addition, Alteration, or Repair?

1.	Converting unheated garage or basement to conditioned space	**Addition**
2.	Adding a baywindow that extends to floor	**Addition**
3.	Replacing broken pane of glass in an existing window	**Repair**
4.	Replacing outdoor unit of split-system central AC	**Alteration**
5.	Replacing failed blower fan wheel, but not whole unit	**Repair**
6.	Replacing indoor coil of split-system central AC	**Alteration**
7.	Replacing hardwired ceiling lights with new hardwired lighting	**Alteration**
8.	Adding a skylight that cuts through existing attic	**Alteration**
9.	Enclosing and conditioning a patio	**Addition**
10.	Replacing a compressor	**Alteration**

Prescriptive Additions

Categorizing Additions by Size

- **≤ 400 ft²**
- **> 400 ft² and ≤700 ft²**
- **>700 and <1,000 ft²**

Prescriptive requirements for additions:

- Have less stringent wall insulation requirements
- Vary based on the size of the addition — for example:
  - Larger additions may have a less fenestration (% of CFA) than smaller additions
  - Additions ≤ 300 ft² are exempt from the Prescriptive cool roof requirements
- Details are in the Standards:
  - Table 150.1-A
  - §150.2(a)1B

Residential Compliance Forms

Residential Compliance Forms: Overview

Appendix A of the Compliance Manual:

APPENDIX A Compliance Forms

PERFORMANCE			
CF1R-PRF-01-E	Additions; Alterations	Enforce Agency	Performance compliance method for newly constructed buildings
PRESCRIPTIVE			
CF1R-NCB-01-E	Newly Constructed Buildings	Enforce Agency	Newly Constructed Buildings and Additions Greater Than 1000 ft^2
CF1R-ADD-01-E	Additions	Enforce Agency	Additions less than 1,000 ft^2
CF1R-ALT-01-E	Alterations	Enforce Agency	Non-HVAC Alterations Break Out by Type
CF1R-ALT-02a-E	Alterations-HVAC	Enforce Agency	HVAC Alterations - New Ducts Greater than 40 ft Length
RCC-CF1R-ALT-02b-E	Alterations-HVAC	Enforce Agency	HVAC Alterations - Equipment or Component Changeout
CF1R-ALT-02c-E	Alterations-HVAC	Enforce Agency	HVAC Alterations - Component Changeout with All New Ducts
CF1R-ALT-02d-E	Alterations-HVAC	Enforce Agency	HVAC Alterations - Entirely New or Replacement System
CF1R-ALT-03-E	Alterations-HVAC	Enforce Agency	Paper version of ALT-HVAC for CZ 1, 3-7,16
CF1R-ALT-04-E	Alterations-HVAC	Enforce Agency	Paper version of ALT HVAC-CZ 2, 8-15
CF1R-ENV-01-E	Work Sheet	Enforce Agency	Worksheet for EZ frame - opaque
CF1R-ENV-02-E	Work Sheet	Enforce Agency	Area Weighted Average Calculation Worksheet
CF1R-ENV-03-E	Work Sheet	Enforce Agency	Solar Heat Gain Coefficient (SHGC) Worksheet
CF1R-ENV-04-E	Work Sheet	Enforce Agency	Cool Roof and SRI Worksheet
CF1R-PLB-01-E	Work Sheet	Enforce Agency	Hydronic Heating System Worksheet
CF1R-SRA-01-E	Work Sheet	Enforce Agency	Solar Ready Areas

Your reference for compliance forms

- In Compliance Manual Appendix A:
  - A full list of compliance forms
  - Copy of each form
- This class will focus on a subset of the forms listed there

2013 Forms Conventions

Document Category

PRF = Performance approach
NCB = Newly construction & additions >1,000 ft^2
ADD = Additions (≤ 1,000 ft^2)
ALT = Alterations
EXC = Existing Conditions
ENV = Envelope
MCH = Mechanical
LTG = Lighting
PLB = Plumbing (DHW)
PHV = Photovoltaic
WKS = Worksheet

(Residential) **Compliance Form** → CF1R-ALT-01-E

Document Type

Certificates of…

1R = Compliance
2R = Installation
3R = HERS Verification

Primary user

E = Enforcement agency
H = HERS

2013 Forms

CF1R
Certificates of Compliance
May need to be registered with HERS Provider

Replace 2008 CF-1R

- Fourteen individual forms — seven are worksheets
- Focus on specific types or aspects of projects — e.g.:
  - Prescriptive new construction
  - Prescriptive HVAC alterations

CF2R
Certificates of Installation
Must be registered with HERS Provider if CF1R is registered

Replace 2008 CF-6R

- Sixty-one individual forms
- Focus on specific features and methods — e.g.,
  - Duct leakage test
    (different variations for different methods of testing)
  - Space conditioning systems, ducts, and fans
    (different variations for different project types and compliance methods)

CF3R
Certificates of Verification
Replace 2008 CF-4R

- Forty-one individual forms
- Focus on specific features that require HERS verification

Who Uses Which Form & When

Design	Designers and Energy Consultants work together to ensure code is met	✦ CF1R ✦ Plans	Prescriptive or Performance Approach HERS Registered if necessary
Plan Review	Plans Examiners review forms; match to plans; alert others as to what is expected	✦ CF1R ✦ Plans	Look for registration information on the CF1R that contain HERS measures
Construction	Builders refer to plans and compliance forms (part of the plan set)	✦ CF1R ✦ CF2R ✦ Plans	Contractors must complete the Certificates of Installation
Inspection, Verification	Building Inspectors' and HERS Raters' activities are guided by plan set	✦ CF1R ✦ CF2R ✦ CF3R	CF1R and CF2R reviewed by Building Inspector CF3R completed by HERS Rater and reviewed by Building Inspector

HERS Registration Verification Process: Overview

CERTIFICATE OF COMPLIANCE - RESIDENTIAL PERFORMANCE COMPLIANCE METHOD

Project Name: Energy Code Ace Training Example
Calculation Description: Existing Floor Plan (New Construction)

Calculation Date/Time: 10:27, Thu, Jun 19, 2014
Input File Name: Training_Example.ribd

GENERAL INFORMATION					
01	Project Name	Energy Code Ace Training Example			
02	Calculation Description	Title 24 Analysis			
03	Project Location	111 First Street			
04	CA City	Anytown, CA	05	Standards Version	Compliance 2015
06	Zip code	95814	07	Compliance Manager Version	BEMCmpMgr 2013-2 (595)
08	Climate Zone	CZ10	09	Software Version	EnergyPro 6.2
10	Building Type	Single Family	11	Front Orientation (deg/Cardinal)	90
12	Project Scope	Newly Constructed	13	Number of Dwelling Units	1
14	Total Cond. Floor Area (FT2)	2000	15	Number of Zones	2
16	Slab Area (FT2)	6000	17	Number of Stories	2
18	Addition Cond. Floor Area	NA	19	Natural Gas Available	Yes
20	Addition Slab Area (FT2)	NA	21	Glazing Percentage (%)	19.5%

COMPLIANCE RESULTS	
01	Building Complies with Computer Performance
02	This building incorporates features that require field testing and/or verification by a certified HERS rater under the supervision of a CEC-approved HERS provider.

Detailed help on using the CF-1R Certificate of Compliance is available via the Internet by either scanning the QR code or browsing to http://www.title24energycode.org/t24help/cf1r.aspx

ENERGY USE SUMMARY

04	05	06	07	08
Energy Use (kTDV/ft^2-yr)	Standard Design	Proposed Design	Compliance Margin	Percent Improvement
Space Heating	6.50	3.96	2.54	39.1%
Space Cooling	30.48	31.25	-0.77	-2.6%
IAQ Ventilation	1.12	1.12	0.00	0.0%
Water Heating	13.91	8.94	4.97	35.7%
Photovoltaic Offset	----	-4.57	1.57	----
TOTAL	**52.01**	**40.70**	**11.31**	21.7%

Forms for Projects with HERS Measures

Key Forms When HERS Verification is Required

Design and Permit Application

CF1R

- **Registered online with HERS Provider**
- Signed and registered copy submitted to enforcement agency

Plan Check and Building Permit

CF1R

- Checked for HERS registration information

Construction and Verification Testing

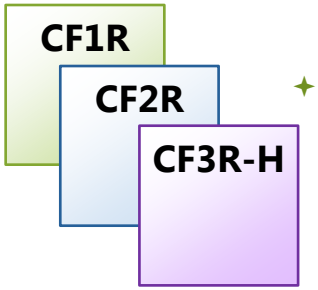
CF2R- XXX-XX

- Signed and submitted to HERS Provider registry after builder or subcontractor installation and testing
- Posted at building site

CF3R- XXX-XX-**H**

- Signed and submitted to HERS Provider registry after HERS Rater verification and testing
- Posted at building site

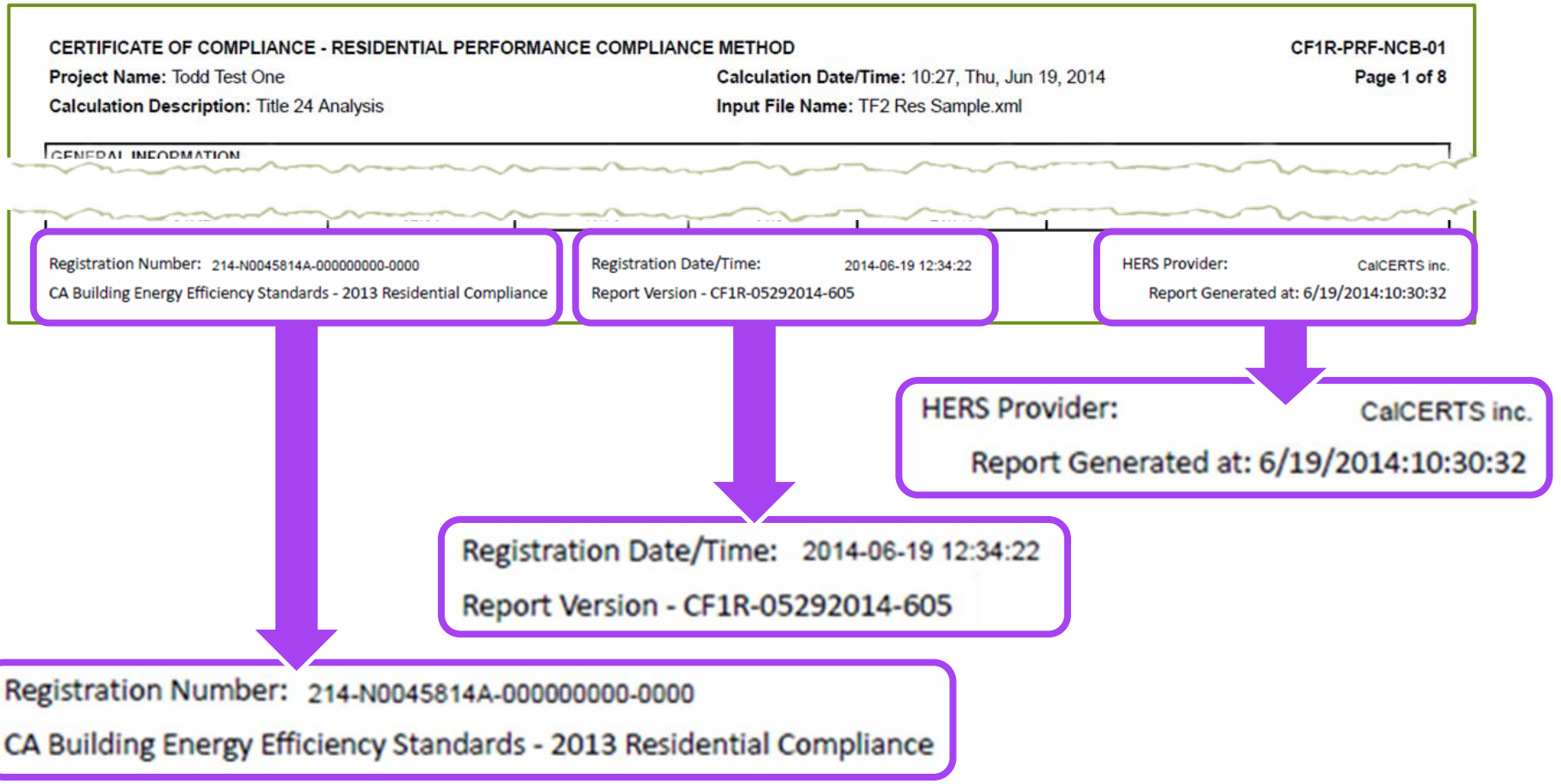
Field Inspection



- Confirmed on-site by Building Inspector

HERS Registration Information on Forms

- Compliance package is prepared by energy consultant or other appropriate author, then data uploaded to the HERS Provider of choice
- CF1R is generated by the HERS Provider
- Signatures are uploaded by consultant and designer and added to CF1R



Residential Envelope Standards

- Welcome and Pre-test
- Introduction
- What's New
- Energy Standards Key Concepts
- Introduction to Plan Review and Field Inspection
- **Residential Envelope Standards**
  - PE Checklist — A Closer Look at 2: Envelope
  - Roofs
  - Insulation
  - HERS Measures for Envelope
  - Fenestration
  - Brown Residence Envelope (New Construction)
  - BI Checklist — A Closer Look at "Envelope" at Various Stages
- Residential Mechanical Standards
- Residential Lighting Standards
- Putting it Together
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Envelope's Impact on Energy Use (cont.)

- Awnings, overhangs, fins, operable shutters, and other exterior shading devices help block solar heat gain through glazed areas
  - Need to be large enough to be effective
  - Required to be permanently attached unless prohibited
- In Performance Approach, model windows with overhangs or side fins separately

Roofs

Solar Ready in New Construction

Single family (Subdivisions ≥10 homes) 250 ft² minimum area — OR

- PV system = 1000 watts or more
- Solar hot water system with 0.50 solar fraction
- 50% potential solar zones are provided
- 150 ft² if meets **one** of **many** exceptions, e.g.:
  - 3-story, but less than 2,000 ft²

  OR
  - CZ 8-14 in fire area, whole house fan

  OR
  - Demand response thermostats installed

No solar zone required if:

- Demand response thermostats

AND

- High efficacy lights at:
  - Kitchen
  - Bathrooms (with vacancy sensor)
  - Utility rooms
  - Garages
  - Outside (with vacancy and photo sensor)

AND

- Every room has a switched receptacle

Mandatory Measures

Labeling Requirements
Section 10-113 (a) and 118 (i)

COOL ROOF RATING COUNCIL ®

	Initial	Weathered
Solar Reflectance	0.40	0.37
Thermal Emittance	0.85	0.84

Rated Product ID Number	0000-0000
Licensed Seller ID Number	0101
Classification	Production Line

Cool Roof Rating Council ratings are determined for a fixed set of conditions, and may not be appropriate for determining seasonal energy performance. The actual effect of solar reflectance and thermal emittance on building performance may vary.

Manufacturer of product stipulates that these ratings were determined in accordance with the applicable Cool Roof Rating Council procedures.

Cool Roof: Prescriptive Requirements

Low-sloped (≤ 2:12)

Climate Zones 13 and 15

- Aged Solar Reflectance ≥ 0.63 AND Emittance ≥ 0.75

OR

- ≥ 75 SRI

Steep-sloped (> 2:12)

Climate Zones 10 through 15

- Aged Solar Reflectance ≥ 0.20 AND Emittance ≥ 0.75

OR

- ≥ 16 SRI

CRRC product data includes both initial and aged (3-year) Solar Reflectance, Thermal Emittance, and Solar Reflective Index (SRI) for all rated products in the directory: http://coolroofs.org/products/results

1 2 3 > 100 ›

CRRC PROD. ID	MANUFACTURER: BRAND MODEL	PRODUCT TYPE	COLOR	SOLAR REFLECTANCE		THERMAL EMITTANCE		SRI		MORE INFO
				initial	3 year	initial	3 year	initial	3 year	
0986-0004	**A-1 Grit Company**: Arctic White Granule size: #11. Tested over a white adhesive. Manufacturer recommends 100% granule coverage for proper performance.	Other Roof Products: Stone Aggregate/Ballast Products		0.73	0.56	0.92	0.90	91	67	+
0986-0005	**A-1 Grit Company**: Glacier White 3/8 inch aggregate. Tested over black asphalt with a maximum solar	Other Roof Products: Stone Aggregate/Ballast	Bright White	0.70	pending	0.85	pending	85	pending	+

Roofing: Prescriptive Alterations

Cool Roof in Alterations

- Cool roof may be required when replacing > 50% of the existing roof surface area
- Many alternatives to meeting the cool roof requirement in steep-sloped roofs:
  - R-38 ceiling insulation
  - Radiant barrier in the attic
  - No ducts in the attic
  - Adding roof deck insulation
- Few alternatives for low-sloped roofs:
  - No ducts in the attic
  - Insulation at roof deck as per Table 150.2-A
  - Integrated photo voltaic panels

Radiant Barriers

Note: an "air gap" is necessary for a radiant barrier to be effective.

Photo by im4t00l, FLICKR http://www.flickr.com/photos/davidkowis/120113044

Prescriptive Requirements

- In climate zones with significant cooling loads (climate zones 2 through 15)
- To qualify, must have emittance ≤ 0.05 (climate zones 2 through 15)
- Most common way of meeting radiant barrier requirement:
  Use roof sheathing with radiant barrier bonded to it in factory

Performance Approach

Allows opportunity to model with or without Radiant barrier

Insulation

Ceiling/Roof Insulation: Mandatory Measures

Attic insulation installed in existing buildings

≥**R-30** for insulation alone (all climate zones)*

Insulation in roof/ceiling constructions

In **direct contact** with **infiltration barrier**

Wood-framed ceiling/roof assemblies

- Insulation: ≥ R-30

or

- U-factor: ≤ 0.031 **

Metal-framed ceiling/roof assemblies

U-factor: ≤ 0.031

Ventilated attic with drywall ceiling for infiltration barrier

Insulation must **lie directly on top of ceiling**

* **Exception:** Insulation of rafter roofs in an alteration, insulation between wood-framing members ≥R-19

** Based on 24 inch on-center wood framed rafter roofs

Wall Insulation: Mandatory Measures

Wood framed wall	Min. Insulation
2x4 inch framing	**≥R-13** or **≤U-0.102** *
2x6 inch framing	**≥R-19** or **≤U-0.074** *
Bay window roof & floor	**Per Package A wall insulation requirements**

Exception: Existing walls with ≥R-11, when using the Performance approach

* See note below slide for explanation of why R-values and U-factors are not mathematically equivalent

Wall Insulation: Prescriptive Requirements

Insulation for Wood-framed Walls (by climate zone)

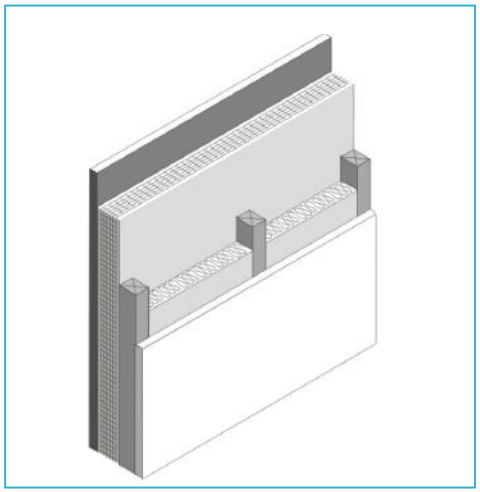
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

U-factor 0.065

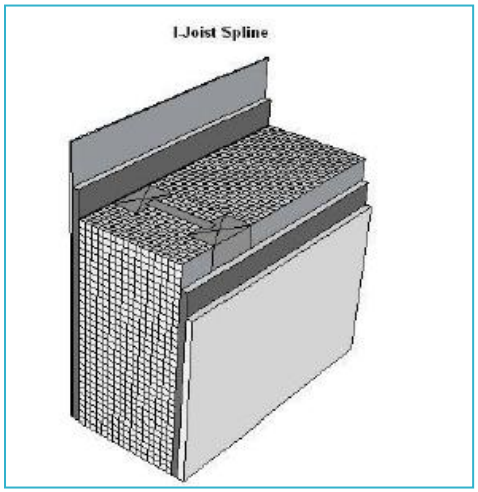
(Any combination of cavity & continuous insulation that achieves this U-factor
For example: R-15+4 or R-13+5)

0.065

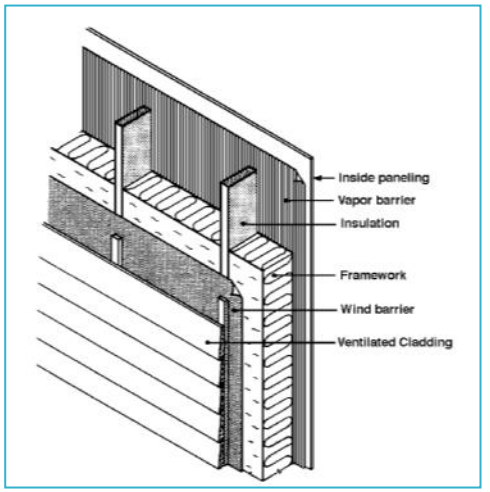
- Wood framed, 2 x 4 16" OC with R-15 with R-4 rigid on outside of framing; **OR**
- 2 x 6 16" OC with R-23 (spray applied); **OR**
- R-18 SIPS



JA4: 4.3.1 R-15 with R-4



JA4: 4.3.2 R-18 (4-1/2")



JA4: 4.3.1 2 x 6 R-23

Floor Insulation: Mandatory Measures

Photo by Eric Rubright
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http://www.flickr.com/photos/arkansascub/3911048012

Wood-framed floors:

- At least R-19 insulation between framing members

or

- Construction assembly must have U-factor of 0.037 or less

Exception:

- Raised floors above controlled ventilation crawlspaces, or unvented crawlspace. See exception §150.0(d)

if

- All eligibility and installation criteria for a controlled ventilated crawlspace are met

Floor Insulation (cont.)
Prescriptive Approach

Package A: Raised Floors (by climate zone)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
R-19 U 0.037															

Concrete Raised Floors (by climate zone)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
R-8 U 0.092		R-0 U 0.269								R-8 U 0.092	R-4 U 0.138	R-8 U 0.092		R-4 U 0.138	R-8 U 0.092

Fenestration

Check Your Understanding

1. What does fenestration include? Select all that apply.

- ☑ a. Skylights
- ☑ b. Windows
- ☑ c. Garden windows
- ☑ d. French doors
- ☑ e. Sliding glass doors
- ☑ f. Any door with a glazed area of more than one half of the door area

Yes, fenestration includes all of these

Maximum U-factor and Fenestration Labeling

- **Maximum weighted U-factor = 0.58**
- Fenestration must have labels at time of inspection
- Labels show U-factor, SHGC
- Values determined from:
  - National Fenestration Rating Council (NFRC)

  or
  - CEC-approved default tables
    - 110.6-A (U-factor)
    - 110.6-B (SHGC)

  or
  - Site-built: Alternative calculations in NA6

Tables 110.6-A and 110.6-B: Default Fenestration U-Factors and SHGC

If it doesn't have a label, the default values must be used

TABLE 110.6-A DEFAULT FENESTRATION PRODUCT U-FACTORS

FRAME	PRODUCT TYPE	SINGLE PANE [3, 4] U-FACTOR	DOUBLE PANE [1, 3, 4] U-FACTOR	GLASS BLOCK [2,3] U-FACTOR
Metal	Operable	1.28	0.79	0.87
	Fixed	1.19	0.71	0.72
	Greenhouse/garden window	2.26	1.40	N.A.
	Doors	1.25	0.77	
	Skylight	1.98	1.30	
Metal, Thermal Break	Operable	N.A.	0.66	
	Fixed	N.A.	0.55	
	Greenhouse/garden window	N.A.	1.12	
	Doors	N.A.	0.59	
	Skylight	N.A.	1.11	
Nonmetal	Operable	0.99	0.58	
	Fixed	1.04	0.55	
	Doors	0.99	0.53	
	Greenhouse/garden windows	1.94	1.06	
	Skylight	1.47	0.84	

1. For all dual-glazed fenestration products, adjust the listed U-factors as follows:
   a. Add 0.05 for products with dividers between panes if spacer is less than 7/16 inch
   b. Add 0.05 to any product with true divided lite (dividers through the panes).
2. Translucent or transparent panels shall use glass block values when not rated by NFR
3. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential App
4. Windows with window film applied that is not rated by NFRC 100 shall use the default this table.

Table 110.6-A:
Default Fenestration U-Factors

Table 110.6-B:
Default Fenestration SHGC

TABLE 110.6-B DEFAULT SOLAR HEAT GAIN COEFFICIENT (SHGC)

FRAME TYPE	PRODUCT	GLAZING	FENESTRATION PRODUCT SHGC		
			Single Pane [2,3] SHGC	Double Pane [2,3] SHGC	Glass Block [1,2] SHGC
Metal	Operable	Clear	0.80	0.70	0.70
	Fixed	Clear	0.83	0.73	0.73
	Operable	Tinted	0.67	0.59	N.A.
	Fixed	Tinted	0.68	0.60	N.A.
Metal, Thermal Break	Operable	Clear	N.A.	0.63	N.A.
	Fixed	Clear	N.A.	0.69	N.A.
	Operable	Tinted	N.A.	0.53	N.A.
	Fixed	Tinted	N.A.	0.57	N.A.
Nonmetal	Operable	Clear	0.74	0.65	0.70
	Fixed	Clear	0.76	0.67	0.67
	Operable	Tinted	0.60	0.53	N.A.
	Fixed	Tinted	0.63	0.55	N.A.

1. Translucent or transparent panels shall use glass block values when not rated by NFRC 200.
2. Visible Transmittance (VT) shall be calculated by using Reference Nonresidential Appendix NA6.
3. Windows with window film applied that is not rated by NFRC 200 shall use the default values from this table

Fenestration Mandatory Measures (cont.)

NFRC Temporary Label

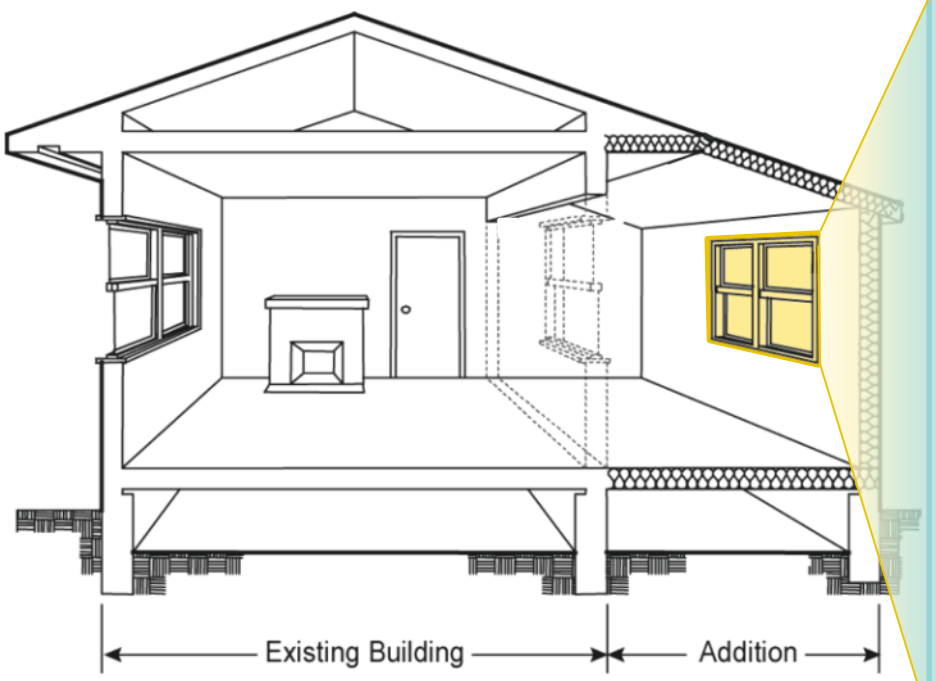
Fenestration Prescriptive Requirements

Package A Requirements for Fenestration

	Climate Zones															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Maximum U-factor	**0.32**															
Maximum SHGC	NR	**0.25**	NR	**0.25**	NR	**0.25**										
Maximum Total Area*	**20%**															
Maximum West Facing Area	NR	**5%**	NR	**5%**	NR	**5%**										

* Percentage of Conditioned Floor Area (CFA)

Fenestration Requirements for Additions



Adapted from Figure 9-2 Compliance Manual

Limit of fenestration area in addition depends on addition size:

≤ 400 ft² addition:

- 75 ft² or 30% of addition's CFA*
- Max west facing = 60 ft² **

> 400 ft² to ≤700 ft² addition

- 120 ft² or 25% of addition's CFA*
- Max west facing = 60 ft² **

> 700 ft² addition

- 175 ft² or 20% of addition's CFA*
- Max west facing = 70 ft² or 5%*, **

* Whichever is greater

** Climate zones 2,4, 6-16 only; no max. west facing requirements in climate zones 1, 3, or 5

Fenestration Requirements for Alterations

Requirements by Fenestration Area Increase
(area of whole window, including frame)

Replace Existing Only* (No Increase in Fenestration Area)

- Vertical fen. ≤75 ft^2
  - U-factor≤0.40
  - SHGC ≤0.35**
- Vertical fen. >75 ft^2
  - U-factor ≤0.32
  - SHGC ≤0.25**
- Skylights
  - U-factor≤0.55
  - SHGC ≤0.30**

Added Fenestration Area ≥1 ft^2 and ≤75 ft^2

- U-factor ≤0.32
- SHGC ≤0.25**

Total and west-facing area requirements do NOT apply

Alterations that add ≤16 ft^2 new skylight area with a maximum U-factor of 0.55 and a maximum SHGC of 0.30 area do not need to meet the total fenestration area and west-facing fenestration area requirements

Added Fenestration Area >75 ft^2

- U-factor ≤0.32
- SHGC ≤0.25**
- Total area ≤20%
- West-facing area ≤5%**

* Applies even if a single window (including frame) is being replaced

** No requirements for climate zones 1, 3, and 5

Residential Mechanical Standards

- Welcome and Pre-test
- Introduction
- What's New
- Energy Standards Key Concepts
- Introduction to Plan Review and Field Inspection
- Residential Envelope Standards
- **Residential Mechanical Standards**
  - PE Checklist — A Closer Look at 3: Mechanical
  - Water Heating (DHW)
  - HVAC
  - BI Checklist — A Closer Look at HVAC and Plumbing at Various Stages
  - Brown Residence Mechanical
- Residential Lighting Standards
- Putting it Together
- Course Conclusion and Post-test

Overview: Why This Topic is Important

- Californians pay a large price for lack of quality installation and maintenance
  - <10% of HVAC system replacements have permits
  - 30-50% of new central air conditioning systems NOT properly installed
- **1,272 MW estimated cumulative savings** from more efficient cooling technologies

  Equivalent to deferring need to build 2 small power plants

Water Heating
(Domestic Hot Water – DHW)

Federal Minimums for Water Heater Efficiency

Water Heaters

		Minimum Energy Factor
Gas Storage ≤55 gallons	Currently:	0.67-(0.0019*V)
	After 4/16/15	0.675-(0.0015*V)
	Example: 50 gal. gas storage	0.675 – (0.0015 * 50) EF = 0.675 – 0.075 EF= **0.60 EF**
Gas Storage >55 gallons	Currently	0.67-(0.0019*V)
	After 4/16/15	0.8012 – (0.00078*V)
Gas Instantaneous ≤200 kBtuh	Currently	0.62
	After 4/16/15	0.82

Minimum efficiencies for other types of water heaters is found at the end of the "Package A Quick Reference" in Module 3: Energy Standards Key Concepts

Water Heating: Mandatory Measures

Insulation requirements

- **Non-recirculating distribution system:** Hot and cold water pipes insulated for first 5 feet from water heater – conditioned or unconditioned space
- **Recirculating distribution system:** Entire hot water length insulated, all sections, buried pipe or exposed pipe
- **Indirect fired hot water system:** From heating source to storage tank
- All **hot water pipes from source to kitchen** fixtures
- All **hot water pipes with ≥3/4" diameter**
- **Hot water piping buried below grade** (waterproof non-crushable casing also required)

- **1 inch of R-4 insulation needed for pipe ≤1 inch diameter when:**
  - Water carried by pipe 105-140°F
  - Insulation conductivity 0.24-0.28 Btu-in/hr-ft2-°F (typical cellular foam pipe insulation)
- **1.5 inches of R-4 insulation needed for pipe >1 inch diameter**

Refer to Compliance Manual 4.3.3 and Section 120.3 in the Standards for details.

Water Heating: Mandatory Measures (cont.)

For new homes:

- 120 V outlet within 3 feet of water heater
- Category III or IV or a type B vent straight to outside
- Condensate drain ≤2 inches higher than base of water heater — no pump
- Gas supply with capacity of 200 kBtuh

Types of Water Heaters

Types recognized by standards:

- Standard water heater – storage gas
  - 50 gallons, gas fired, ≤75 kBtuh
- Large storage gas – either
  - >50 gallons, gas fired

  OR
  - >75 kBtuh
- Storage electric
- Heat pump water heater with storage
- Tankless gas
- Tankless electric
- Solar thermal supplement
  (requires CEC F-Chart, Form CF-SR)
- Boiler and storage tank (mostly multifamily)

If the CF1R shows an energy factor ≤0.58, check:
Do the plans and CF1R call for an external insulation blanket ≥R-12?

Water Heating: Prescriptive Approach

- Package A (for systems serving individual dwelling units) allows:
  - **Gas storage type water heater:** input capacity **≤ 75 kBtuh**
  - **Gas tankless water heater:** input capacity **≤ 200 kBtuh**
  - **Recirculating systems** must have manual control pumps
- **Electric-resistance storage or electric instantaneous** water heaters are allowed when:
  - Natural gas is unavailable

  AND
  - The project meets other requirements (e.g., solar thermal domestic hot water system)

Using the Prescriptive Approach, an existing electric water heater cannot be replace with another electric water heater if the home has a natural gas meter.

HVAC

Federal Minimums for HVAC Efficiency

Air Conditioners (cooling capacity <65 kBtuh) and **Central Gas Furnaces** (heating capacity <225 kBtuh)

Minimum cooling efficiency

Until 2015: SEER = 13

After 1 January 2015:

- **Split Systems <45 kBtuh**
  SEER = 14 EER = 12.2
- **Split Systems ≥45 and <65 kBtuh**
  SEER = 14 EER = 11.7
- **Single Package ≥45 and ≤65 kBtuh**
  SEER = 14 EER = 11.0

Minimum heating efficiency

- **Gas Central Furnace <225 kBtuh**
  AFUE = 80%

Minimum efficiencies for other types of space conditioning systems is found at the end of the "Package A Quick Reference" in Module 3: Energy Standards Key Concepts

Federal Minimums for HVAC Efficiency

Heat Pumps

Cooling mode minimum efficiencies

Until 2015: SEER = 13

After 1 January 2015:

- **Split Systems <45 kBtuh**
  SEER = 14 EER = 12.2
- **Split Systems ≥45** and **<65 kBtuh**
  SEER = 14 EER = 11.7
- **Packaged System ≥45** and **≤65 kBtuh**
  SEER = 14 EER = 11.0

Heating mode minimum efficiencies

- **Split Systems**
  HSPF = 8.2
- **Packaged System**
  HSPF = 8.0

Cooling: Prescriptive Approach

Prescriptive Requirements for Refrigerant Charge Verification

Package A

Climate Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Refrigerant Charge Verification OR **Charge Indicator Display**	NA	REQ	NA					REQ								NA

HERS verification required when refrigerant charge measurement required.

This now includes packaged units and mini-splits as well as traditional split systems and heat pumps.

Prescriptive Night Ventilation Cooling Requirements

Insulated Whole House Fan with Damper Actuation

Ducted Remote Whole House Fan

Source (both graphics):
2013 Residential Compliance Manual

Whole House Fan (WHF) is required for climate zones 8 through 14

- Only whole house fans listed in the Appliance Efficiency Directory may be used
- One or more WHF may be used to meet airflow of ≥2 CFM/ft^2 of CFA
- ≥1 ft^2 attic vent free area for each 375 CFM of rated WHF air flow CFM
- Homeowners with WHFs must receive a one-page "How to operate your whole house fan" informational sheet

A central fan-integrated system may be used instead of WHF to meet the night ventilation cooling requirements

Air Distribution (Ducts and Plenums)

- Big impact on overall HVAC system efficiency
- Duct efficiency affected by:
  - Duct location *(in attic, in conditioned space, etc.)*
  - Specific conditions in the unconditioned space *(e.g., radiant barrier)*
  - Duct insulation characteristics
  - Duct surface area
  - Air leakage

Air Distribution: Mandatory Measures

Photo courtesy of Douglas Beaman Associates LLC

In all climate zones, all ducts must be:

- Insulated to R-6 or higher

  OR

  Enclosed entirely in conditioned space (requires HERS verification)

- Sealed and leakage rate verified by a HERS Rater

  Leakage rates are % of nominal system air handler air flow

Air Distribution: Prescriptive Approach

Package A: Requirement varies between **R-6 and R-8.0** depending on climate zone

Package A															
Climate Zone	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Duct Insulation	R-6										R-8	R-6		R-8		

IAQ and Mechanical Ventilation

- New Construction and Additions >1,000 ft^2
  - Must meet IAQ requirements
  - Require HERS verification of ventilation system performance
- Window operation is not an alternative

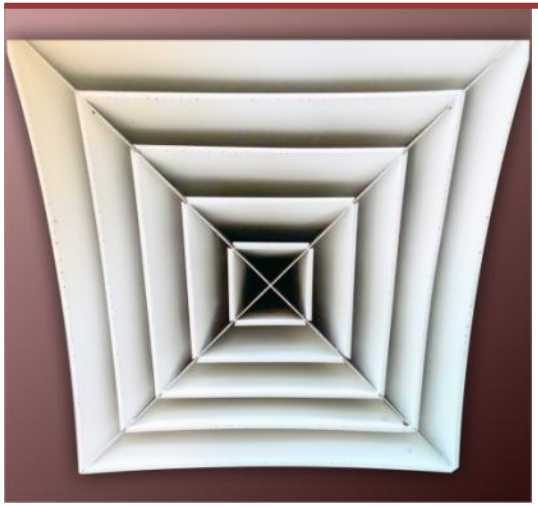
  Windows for ventilation in habitable rooms are still required, with an opening of at least 4% of the floor area

IAQ and Mechanical Ventilation (cont.)

Two Primary Requirements

Local exhaust ventilation

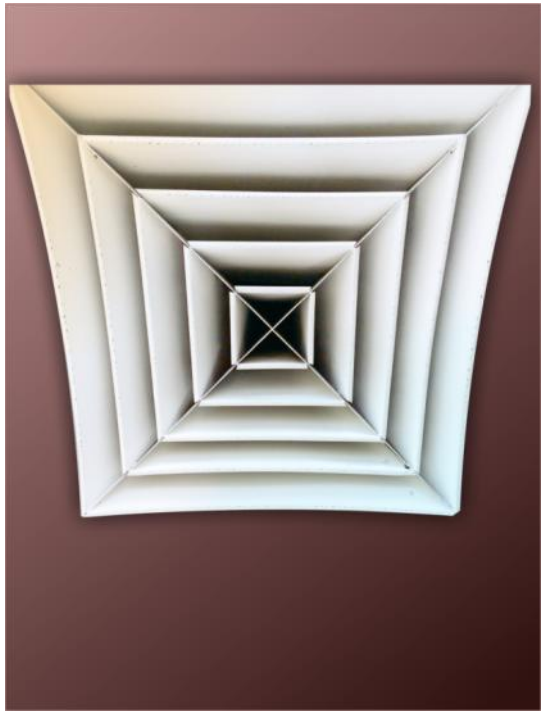
- Kitchen fan (no recirculation fans)
- Bathroom fan
- Laundry room with dryer vent to outside



Whole-house IAQ ventilation

- Intermittent fan
- Continuous fan
- HVAC

Solutions for Whole-house IAQ Ventilation



- Three generic solutions to meeting requirements for Whole-house ventilation for indoor air quality (IAQ):
  - Exhaust ventilation (most common)
  - Supply ventilation
  - Combination of supply and exhaust
- Whole-house IAQ ventilation can be achieved through:
  - Single dedicated fan or system of fans

  OR
  - Fans that also provide local exhaust or distribute heating and cooling
- May operate continuously or intermittently

  If central fan integrated system, it must be intermittent

Ventilation system performance must be HERS verified

Calculating Required IAQ Ventilation Rate

- Use this formula:

$$\text{Ventilation Rate (cfm)} = \frac{\text{CFA}}{100} + \left[7.5 \times (\text{Number of Bedrooms} + 1)\right]$$

OR

- Use Table 4-14 in Residential Compliance Manual

Table 4-14 – Continuous Whole-building Ventilation Rate (cfm)

Conditioned Floor Area (ft^2)	Bedrooms				
	0-1	2-3	4-5	6-7	>7
≤1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
>7500	105	120	135	150	165

Setback Thermostats

Always required for central systems whether Prescriptive or Performance — unless an energy management control system (EMCS) is used

Exceptions:

- Gravity wall, floor and room heaters
- Noncentral electric heaters
- Gas fireplaces and decorative appliances
- Wood stoves
- Room air conditioners and heat pumps

New or Replacement Systems

It's a **new or replacement system** when it's:

- All of the system heating/cooling equipment — e.g.:
  - An entire split AC system

  OR
  - An entire furnace

  OR
  - A package unit

AND

- Entirely new or replacement duct system

Requirements are**:**

- Meet all applicable mandatory and Prescriptive requirements, including:
  - Duct leakage testing
  - Verified minimum cooling coil airflow > **350 cfm/ton** of nominal cooling capacity
  - Verified fan watt draw measurement ≤ **0.58W/cfm**

  OR
  - Verified return duct sizing according to Table 150.0-C or 150.0-D
- Form CF1R-ALT-03 (CZ 1, 3-7, 16) or ALT-04 (CZ 2, 8-15)

Altered Space Conditioning System

It's an **altered system** when it's:

- Alteration by the installation or replacement of:
  - The air handler or heat exchanger
  - Any refrigerant-containing component, such as:
    - Outdoor condensing unit or condensing coil
    - Compressor
    - Indoor unit or cooling coil
    - Refrigerant meter or refrigerant piping

Requirements are**:**

- All applicable Mandatory Measures and Prescriptive requirements, including:
  - Ducts sealed and verified
  - Setback thermostat
  - Refrigerant charge verification requirement
  - Minimum cooling coil airflow **>350 cfm/ton** of nominal cooling capacity and fan watt draw
- Form CF1R-ALT-03 (CZ 1, 3-7, 16) or ALT-04 (CZ 2, 8-15)

Residential Lighting Standards

- Welcome and Pre-test
- Introduction
- What's New
- Energy Standards Key Concepts
- Introduction to Plan Review and Field Inspection
- Residential Envelope Standards
- Residential Mechanical Standards
- **Residential Lighting Standards**
  - PE Checklist — A Closer Look at 4: Lighting
  - Luminaire Efficacy
  - Switching Requirements
  - Lighting Requirements by Area (Room)
  - BI Checklist — A Closer Look at Lighting at Various Stages
- Putting it Together
- Course Conclusion and Post-test

Overview of Residential Lighting

- **ALL lighting requirements are Mandatory Measures**
- Lighting energy is NOT part of energy budget for the whole building
- No tradeoffs between lighting and other features
- Low-efficacy lighting must be switched separately from high-efficacy lighting
- Standards apply only to permanently installed luminaires (light fixtures)

Luminaire Efficacy

Ace Training™

Residential High Efficacy Requirement

Typical Systems that Qualify

- Pin-based fluorescent lamps with electronic ballasts (including pin-based CFLs)
- LED lighting certified to the Energy Commission as high efficacy
- Metal halide lighting (a type of HID lamp)
- High Pressure Sodium (a type of HID lamp)
- Induction Lighting

GU-24 CFL photo courtesy of Conservation Law Foundation

Typical Systems that Do NOT Qualify

- Any screw-based lamps
- Mercury vapor lamps (a type of HID lamp)

Photo of mercury vapor lamp by Ulfbastel on wikimedia http://commons.wikimedia.org/wiki/File:Gasentl3.jpg

Switching requirements

- Separate switching
  - High efficacy luminaires switched separately from low efficacy luminaires. 150.0(k)2A
  - Exhaust fans switched separately from lighting systems, or can be switched OFF in accordance with EXCEPTION.* 150.0(k)2B
- Other controls requirements
  - Luminaires switched with readily accessible controls that permit luminaires to be manually switched ON and OFF. 150.0(k)2C

* **EXCEPTION:** Lighting integral to an exhaust fan may be on the same switch as the fan provided the lighting can be switched OFF while allowing the fan to continue to operate for an extended period of time.

Kitchen Lighting

- No limits to total number of watts installed in a residential kitchen
- At least **50%** of total rated wattage of permanently installed kitchen lighting must be **high efficacy** (not counting internal cabinet lighting)
- Additional low efficacy lighting can be used **if all lighting in the kitchen is** controlled by vacancy sensors or dimmers:
  - Up to 50 W in dwellings ≤2,500 ft^2
  - Up to 100 W dwellings >2,500 ft^2
- Lighting must meet the switching and control requirements

- Included in wattage calculations: ballasts, transformers, and power supplies
- Blank electrical boxes calculated as 180 watts of low efficacy lighting per electrical box

Kitchen Lighting (cont.)

Lighting Internal to Cabinets

- NOT considered when calculating 50% high efficacy lighting in the kitchen (if installed only to illuminate the inside of cabinets)
- Limited to no more than 20 W per linear foot of illuminated cabinets

Lighting in Bathrooms, Garages, Laundry Rooms, Utility Rooms

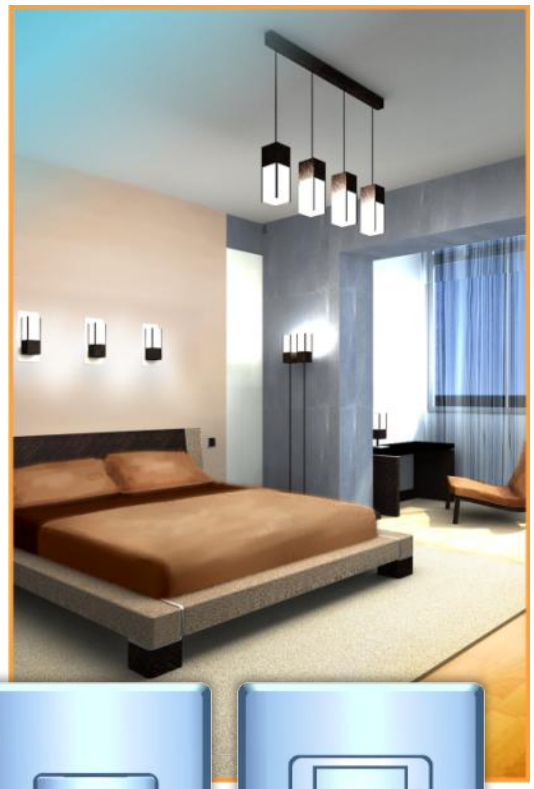
Bathroom

- At least one high efficacy luminaire
- All low efficacy lighting must be controlled by vacancy sensors

Garage, laundry room, utility room

- All must be high efficacy
- All must be controlled by vacancy sensors

Compliance in Other Rooms



Three compliance options for any room or area that is **NOT** a kitchen, bathroom, laundry, utility room, or garage:

- Must be **high efficacy** lighting

or

- Must be controlled by **vacancy sensor**

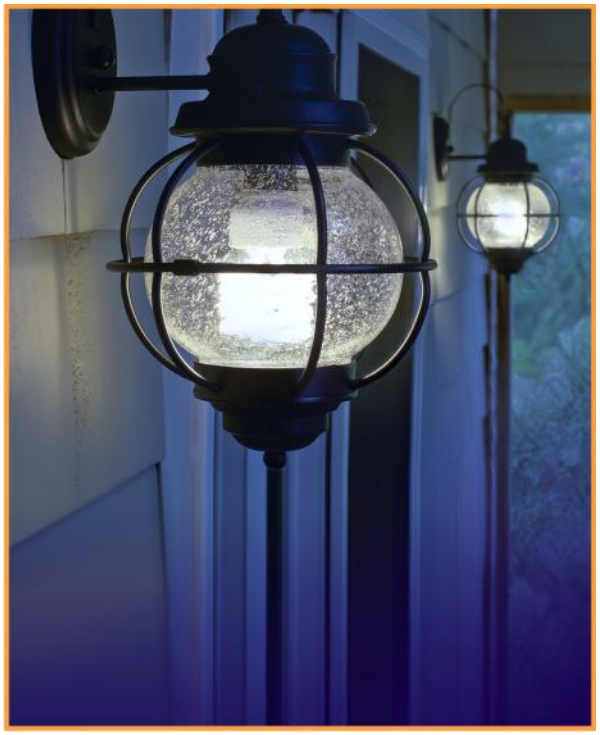
or

- Must be controlled by a **dimmer**

Examples of "other" rooms include:

- Closets ≥70 ft^2 (smaller closets are excepted)
- Bedrooms
- Dining rooms, family rooms, living rooms
- Home offices
- Hallways
- Club houses

Outdoor Lighting



Permanently installed outdoor lighting is mounted or attached to residence or other buildings on the same lot

- Must be **high efficacy** lighting

OR

- Must be controlled by a **motion sensor**

AND controlled by one of these:

- **Photocontrol**

OR

- **Astronomical time clock**

OR

- **Energy management control system** (EMCS)